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# Wi-Fi-based network systems design over freshwater: Experimental evaluation using COTS devices

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## Abstract

# Wi-Fi-based network systems design over freshwater: Experimental evaluation using COTS devices

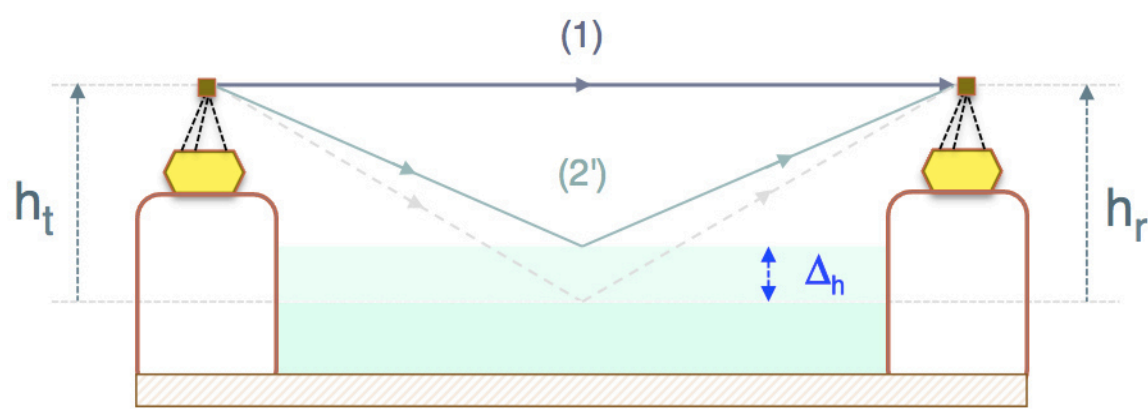
## Motivation

- In the design of **shore-to-shore** and **shore-to-vessel** links, the impact of the **signal reflections** on the surface is often neglected.
- When choosing an antenna height for an inshore node, a typical decision is to use the **largest possible height**; but, this approach can lead to **signal degradation**.

**Objective:** To experimentally assess the impact of surface reflection on the received signal strength of a set of short-and-medium-range shore-to-shore links (<200 m) that use antennas installed at two heights, at a few meters above surface (<3 m).

## Two-ray model

- The **two-ray** is the most fundamental path loss model to account for the influence of **signal reflections** on the received power [1].
- This condition gets further aggravated at near-shore areas as **tides** impose a **variation of the reflection geometry** over time [2].

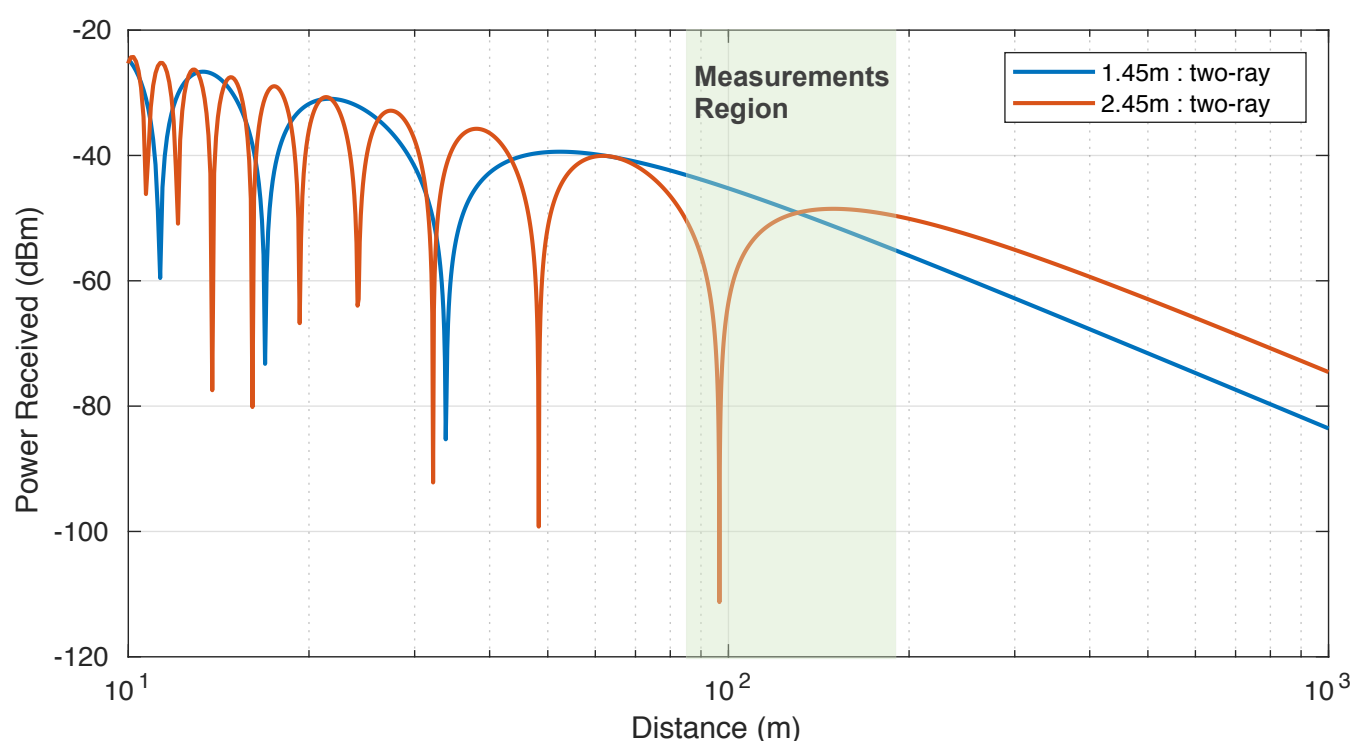


Two-ray model at two different time instants

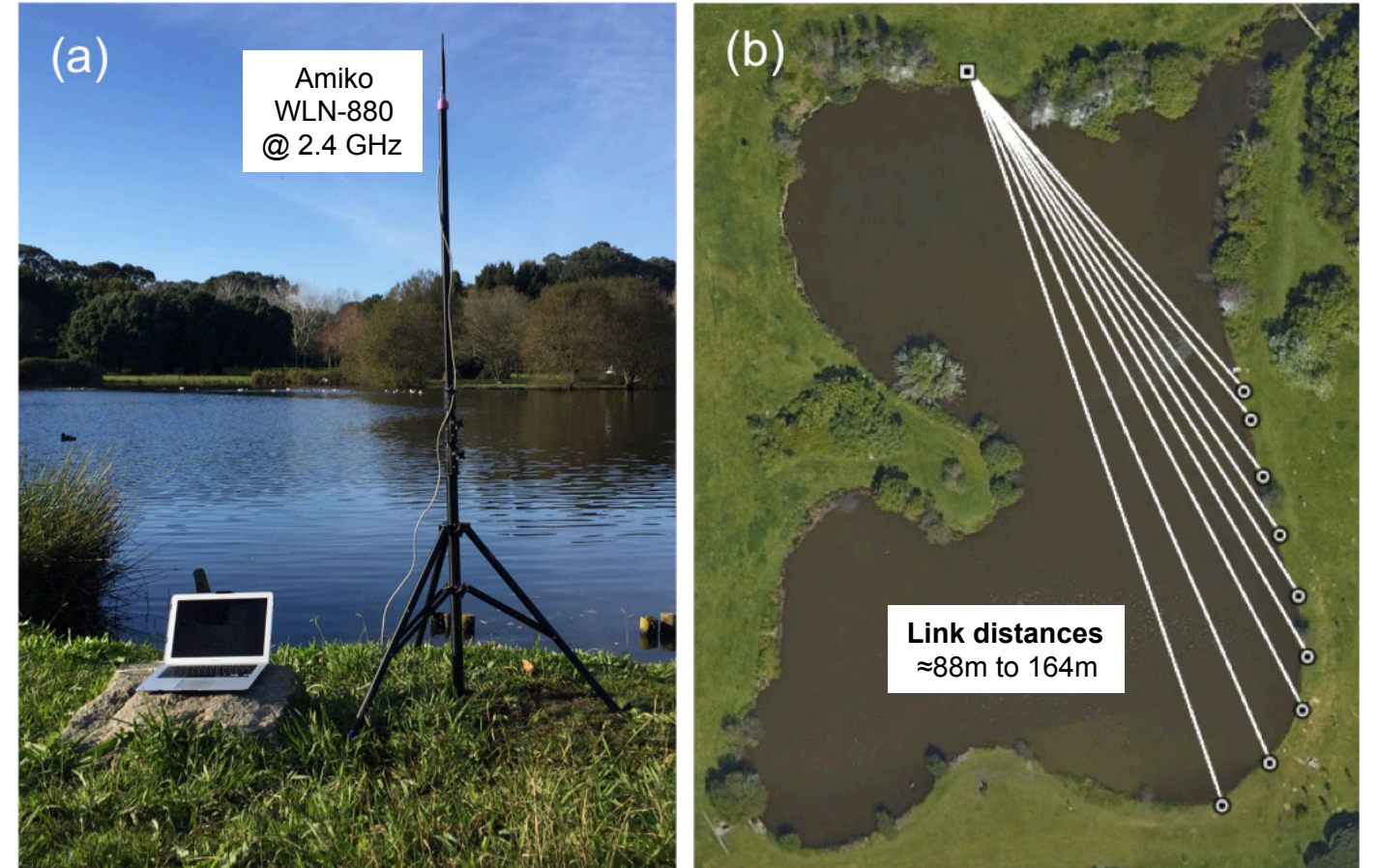
$$P_r = \frac{\lambda^2}{(4\pi d)^2} \left[ 2 \sin\left(\frac{2\pi h_t h_r}{\lambda d}\right) \right]^2 P_t G_t G_r$$

## Simulation results

- In the set of link distances and antenna heights that we explore, the **two-ray model** predicts the occurrence of **strong path loss attenuation** (due to the reflected ray) at well-defined distances.

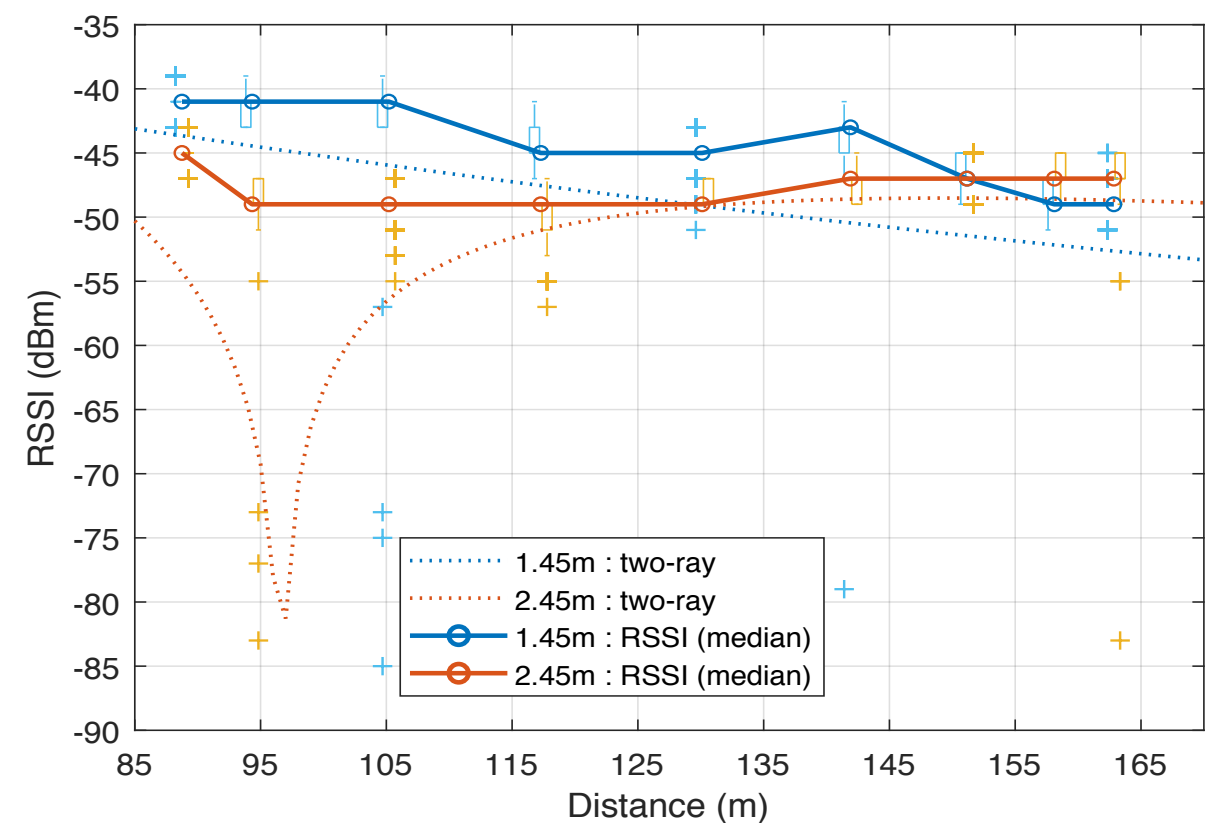


## Testbed



The experimental setup showing: (a) a representative node deployment at the actual location, and (b) the set of links and nodes positions evaluated.

## Experimental Results



Two-ray model (dotted) vs. RSSI measurements at different link distances and antenna heights (boxplot); with median points connected (solid).

## Conclusion & Future work

- We observed **considerable consistency** between packet-based measurements of RSSI and the two-ray model estimates.
- These results provide strength to the claim that both the **two-ray model** and **antenna height adjustment** are key building blocks for effective design of over-water links in coastal environments.

## References

- [1] T. Rappaport, Wireless Communications: Principles and Practice. USA: Prentice Hall PTR, 2nd ed., 2002.
- [2] M. Gutiérrez Gaitán, L. Pinto, P. M. Santos, and L. Almeida, "On the two-ray model analysis for overwater links with tidal variations," in 2019 Proceedings of the 11th National Symposium on Informatics (INForum), 2019.